



Building Design, Maintenance, and Operations



Ventilation

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Inadequate ventilation is a common cause of poor indoor air quality (IAQ) in schools. Increasing the amount of outdoor air entering the building can help dilute polluted indoor air. Local building codes and voluntary standards set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) specify the quantity of outdoor air that should be supplied to schools. Since ventilation systems vary from school to school, schools and districts must determine the pollutant sources and pathways in their buildings.

The U.S. Environmental Protection Agency's (EPA) *Indoor Air Quality Tools for Schools (IAQ TFS)* Program provides more information about recommended ventilation rates for schools. The schools featured in this case study have taken simple, effective measures that have helped to create healthier indoor environments with adequate fresh air. Some examples of measures taken include monitoring carbon dioxide (CO₂) levels in classrooms; ensuring CO₂ levels are consistent with ASHRAE's recommendations; applying an antimicrobial sealant to ducts; changing air filters quarterly; replacing standard filters with high efficiency filters; and cleaning drip pans and drains regularly.

Volusia County School Board, Daytona Beach, Florida

Volusia County School Board in Daytona Beach, Florida, has upgraded their schools' ventilation systems to ensure they are as effective and efficient as possible. When beginning the IAQ program, the Board focused on upgrading air handling units. In recent years, however, the IAQ Team has shifted its focus to air conveyance systems, specifically to systems with interior lining and ductwork. Antimicrobial sealant is now used in the systems to help eliminate various health issues.

The IAQ program receives full financial support from the Board's operations and maintenance budget. The environmental services department provides an annual budget of almost one million dollars, which funded the purchase of analysis equipment, such as a microscope and stain, pumps, particle meters, carbon dioxide detectors, odor meter, and airflow equipment.

To save time and money, samples are analyzed in-house. This capability helps Volusia County achieve its goal of responding to complaints and incidents within 24 hours. The Board has established a five-step process to address IAQ complaints within this short time frame. Based on analyses of samples collected, approximately 20 percent of all complaints are associated with airflow issues.

The Volusia County School Board received an *IAQ TFS* Excellence Award from EPA in December 2003 for its commitment to improving IAQ in its schools and protecting the health and safety of its students and staff.

Blue Valley Unified School District #229, Overland Park, Kansas

Facilities in Blue Valley Unified School District #229 in Overland Park, Kansas, are vulnerable to extreme temperatures. In response, the district has constructed most of its new buildings with a four-pipe HVAC system. In two prototype elementary schools, Blue Valley has incorporated a displacement air system with under-floor air delivery at a scale that is unprecedented for school districts in the United States.

In further efforts to improve IAQ in facilities, the District's maintenance staff now changes air handling filters four times per year (instead of two times per year). The District also installed an upgraded mechanical system, re-insulated window frames, and minimized gaps in door thresholds to reduce the exchange of outdoor and indoor air in several existing facilities. In addition, they installed pre-filters on all room air returns, replaced and upgraded major HVAC units to increase fresh air exchanges, installed carbon dioxide detectors in new classrooms, and retrofitted several existing classrooms. In addition to improving IAQ, the new mechanical systems installed at one of the district's high schools saved the district \$23,000 in energy costs during the first year alone. Over the long term, the District will enjoy significant cost savings. The District's proactive approach to addressing IAQ helped them achieve national recognition with EPA's *IAQ TFS* Excellence Award in 2003.

Rochester Public Schools, Rochester, Minnesota

Rochester Public Schools (RPS) discovered that many of their buildings did not meet the current ASHRAE standard ventilation rate of 15 cubic feet per minute per person for school classrooms. RPS tested all HVAC systems for airflow. They used the test data to prioritize HVAC upgrades for sites not meeting current standards. These priority upgrades will be funded as part of the District's ten-year major maintenance plan.

RPS was one of the first districts in Minnesota to meet all *IAQ TFS* criteria and one of a few districts to have met the *IAQ TFS* criteria every year since 2001. RPS has continuously fine-tuned and improved their IAQ Plan to meet new challenges. In October 2003, RPS received an *IAQ TFS* Excellence Award at the U.S. EPA's 4th Annual *IAQ TFS* National Symposium in Washington, D.C. This award signifies the District's commitment to improving the IAQ in its schools and protecting the health and safety of students and staff.

Salt Lake City School District, Salt Lake City, Utah

Meadowlark Elementary School, located in Salt Lake City School District, experienced ongoing problems with pigeons nesting in and around their ventilation units. The District attempted to scare away the pigeons using a variety of methods, including spiked wire, noisemakers, duct cleaning, and rubber owls and snakes. Since none of these methods were successful, the District had to gain the support of the business administrator to resolve the problem through more intensive measures. With the support of the local health department, the District was able to convince the school business administrator of the importance of eliminating the pigeons. The District compiled medical reports and data showing the diseases that can be carried in the birds' fecal matter. During a remodeling of the school in 2002, the District was able to reposition the ventilation units to make nesting unattractive and unavailable to the pigeons.

In an effort to provide the best possible ventilation, the District installed evaporative cooling systems in as many schools as possible. These systems are extremely effective in the Southwest and provide 100 percent fresh air when they are in cooling mode (i.e., they do not recirculate air). The air passes through both a filter and an air washer, significantly reducing the amount of dust in the building. The ducts must be kept very clean and are flushed regularly with water. The schools also clean the drip pans regularly to remove any standing water where mold and algae can grow.

The Salt Lake City School District constantly monitors building ventilation rates to help prevent IAQ issues from arising. When a problem does occur, the District educates and works closely with affected individuals to resolve the issue. As a result of their dedication to improving and maintaining IAQ, the District received an *IAQ TFS* Excellence Award from EPA in 2003.

Adams Twelve Five Star Schools, Thornton, Colorado

Adams Twelve Five Star School District in Thornton, Colorado, effectively addressed problems with high carbon dioxide levels in their schools. Before 2000, the District saw a steady increase in IAQ complaints from staff, students, and parents. In 2000, staff concerns about IAQ in an elementary school led the District to enlist the help of the local health department in assessing the building's IAQ. They discovered that carbon dioxide levels exceeded the ASHRAE standards in nearly every classroom throughout the District. As staff continued to educate themselves about IAQ issues, their concern grew, motivating them to incorporate IAQ standards into their 2001 union contracts.

In March 2001, the District created an Environmental Manager position to provide input on environmental health issues for the District. Investigation into the cause of the IAQ problems uncovered significant mechanical inefficiencies in many of the older schools. During the 1980s, a few elementary schools were modified from open school plans to traditional floors plans. Since the air handling systems in those schools were not designed to maintain enclosed classrooms, the interior modifications on those schools created some challenging air handling issues. The District decided to tackle these problems by creating an IAQ Team and an Indoor Air Quality Management Plan.

When the IAQ Team conducted walkthrough evaluations of the District's schools, the following problems were revealed:

- ▶ General inadequacy of the air-handling system infrastructure in the remodeled schools.
- ▶ Problems with bringing in enough fresh air to promote air circulation in classrooms.
- ▶ Inadequacy of the HVAC systems, caused by a variety of mechanical problems.

A number of improvement projects were completed to address these ventilation issues, including extensive remodeling of the HVAC systems at many schools. Overall, many of the IAQ problems have proven to be operational issues that can be corrected by behavioral modification efforts and staff education.

The District shifted from a purely reactionary mode for addressing high CO₂ levels in classrooms to a proactive approach to prevent IAQ issues. For example, monthly CO₂ monitoring has been instituted at every school to monitor air exchange. The process uses a Monitoring Form and a Custodial Request Questionnaire, which has been specifically updated to address IAQ issues. The District invited Dr. Richard Shaughnessy, with the University of Tulsa, to visit the District and present seminars on the *IAQ TFS* Program for HVAC technicians, resulting in the creation of an HVAC checklist. District staff have been instructed on how to use an IAQ Concern Form to voice and document IAQ issues in their buildings.

The steps taken to implement the IAQ Management Plan have helped to heighten trust between the administration and teaching staff. EPA commended the District's IAQ efforts to correct and prevent ventilation issues in 2003 with an *IAQ TFS* Excellence Award.

Clovis Unified School District, Clovis, California

Clovis West High School (CWHs) in Clovis, California, has identified and resolved a variety of ventilation issues. In the late 1990s, staff in the portable classrooms reported poor air circulation and unpleasant odors. At that time, the maintenance staff serviced all air conditioning units, installed high efficiency filters, set back thermostats, fully opened outside air dampers, and instructed the staff to run their indoor fans for one hour before and after school. Although these steps were effective in correcting many IAQ concerns, teachers failed to continue practicing the steps necessary to promote good air ventilation, and the number of IAQ complaints increased.

In response to these complaints, the District formed an IAQ Team and began to investigate causes. The Team completed a walkthrough and subsequent investigations in September 2000, during which the Team identified the following problems with ventilation:

- ▶ Inadequate quantities of fresh air were being circulated in the portable classroom buildings because of duct work positioning.
- ▶ Noise from the ventilation systems interfered with classroom learning, causing staff members to turn off the units. This, in turn, led to poor air circulation and musty odors.
- ▶ Fans in several of the HVAC units were not programmed to run continuously while occupants were in the room. This affected IAQ in the classrooms.
- ▶ Condensation from HVAC units leaked, creating a potential source of moisture and mold problems.

The following ventilation improvements were completed at CWHS with little or no cost to the District:

- ▶ The school's air quality team redirected the duct work in the portable classrooms to remedy noise interference and to provide continuous introduction of outside air.
- ▶ In response to poor air circulation in classrooms, thermostats were adjusted for more appropriate schedules that would not interfere with teaching.
- ▶ In classrooms where carbon dioxide levels were recorded at levels over 1,000 parts per million, teachers were educated about how they could help maintain good ventilation, especially in stuffy or overcrowded classrooms.
- ▶ The school maintenance staff serviced all HVAC units; replaced filters with high-efficiency filters; and cleaned coils, condensate pans, and drains.

After making facility repairs, the IAQ Team conducted several follow-up visits to ensure that IAQ improved in the affected areas. EPA recognized the District's efforts to improve IAQ in October 2003 with an *IAQ TFS* Excellence Award.

Summary

As these examples demonstrate, adequate ventilation is essential for good IAQ. Many ventilation problems in schools, such as blocked intakes and vents, are often simple and inexpensive to resolve. The cost savings and improved health associated with good ventilation can be significant. Schools and districts can find more information about ventilation and EPA's *IAQ TFS* Program, including the *IAQ TFS* Kit and the *IAQ TFS* Awards Program, at www.epa.gov/iaq/schools.